

BIOTECHNOLOGY & ITS APPLICATIONS

* Biotechnology deals with Industrial scale production of biopharmaceuticals & biologicals

Novel capabilities ← to bring in these org. their metabolic machinery ← microbes, fungi, plants, animals ← using genetically modified org.

* Application of Biotechnology include: Therapeutics, diagnostics, Genetically mod. crops for agriculture, Processed food, Bioremediation, Waste treatment, energy prod.

* 3 critical Research areas of Biotechnology are:

(i) Providing the best catalyst in form of improved organism usually microbe or pure Enz. through engineering for catalyst to act

(ii) Downstream processing technologies to purify protein or organic comp.

Biotechnological Applications in Agriculture

* 3 options that can be thought for ↑↑ food production

Agro-chemical based agriculture

Organic agriculture

Genetically engineered crop based agriculture.

GREEN REVOLUTION → Succeeded in 3X Food supply but yet Not enough to feed growing human population.

• Increased yields partly due to Use of improved crop varieties
mainly due to Use of better management practices
use of agrochemicals (pesticides, insecticides)

• However → For farmers in developing world. Agrochemical too expensive.

Further ↑ in yield not possible with existing varieties using conventional Breeding

Use of Genetically modified Crops $\xrightarrow{\text{solution to}}$ Above problems

GMO (Genetically Modified Organism)

organism whose genes are altered by manipulation

- Plants
- Bacteria
- Fungi
- Animals

★ Genetic Modification has 3

i) made crops more tolerant to Abiotic Stress

- Cold
- drought
- Salt
- heat

ii) reduced reliance on Chemical pesticides → Pest Resistant crops.

iii) helps reduce Post harvest Losses.

iv) increase efficiency of mineral usage by plants

prevents early exhaustion of fertility of soil

v) enhanced nutritional value of food — eg → Golden rice.
(Vitamin A enriched)

• GM has been used to create tailor made plants to supply Alternative resources to industries.

in terms of

- Starches
- Fuels
- Pharmaceuticals

* (Bt Toxin) produced by Bacterium: Bacillus Thuringiensis

has been cloned from Bacteria → been expressed in Plants to provide Resistance to insects without need of insecticides.

Bt pesticide in effect creates a

Examples of Plants

Bt cotton, Bt corn, Bt rice, Bt tomato, Bt potato, Bt soyabean.

Bt Cotton

Some strains of Bacillus thuringiensis

produce

Proteins

that kill certain insects such as

Lepidoptera

- tobacco budworm
- Army worm

Coleoptera

- beetles

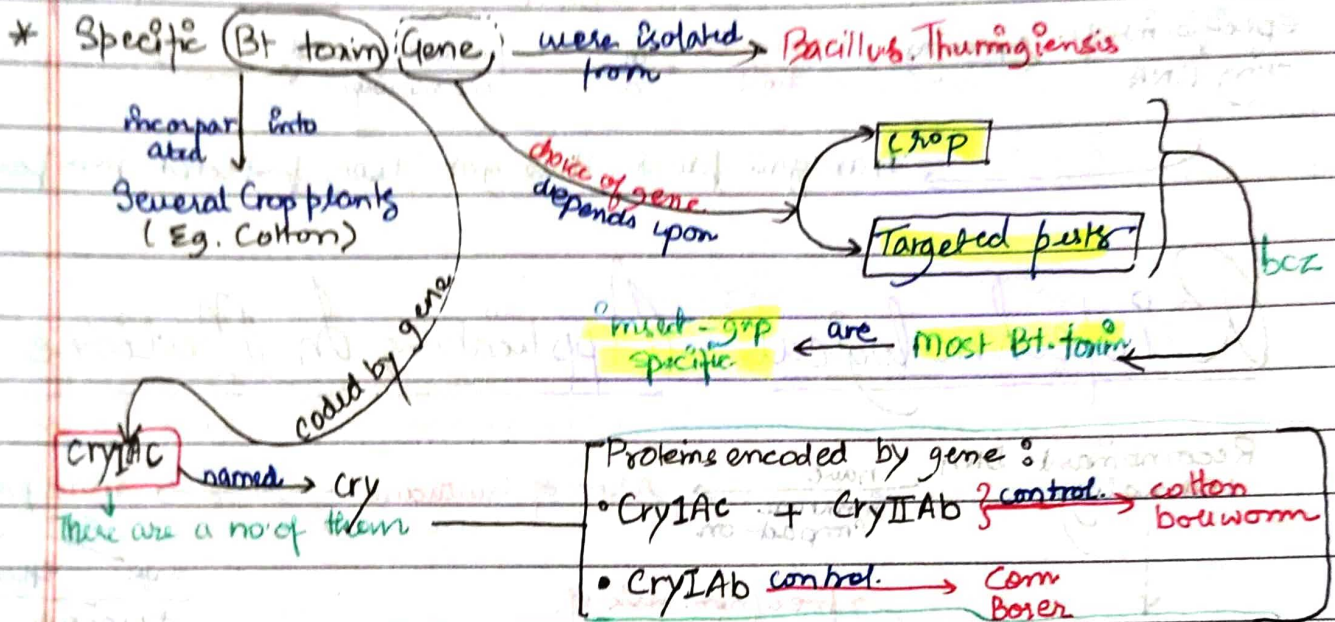
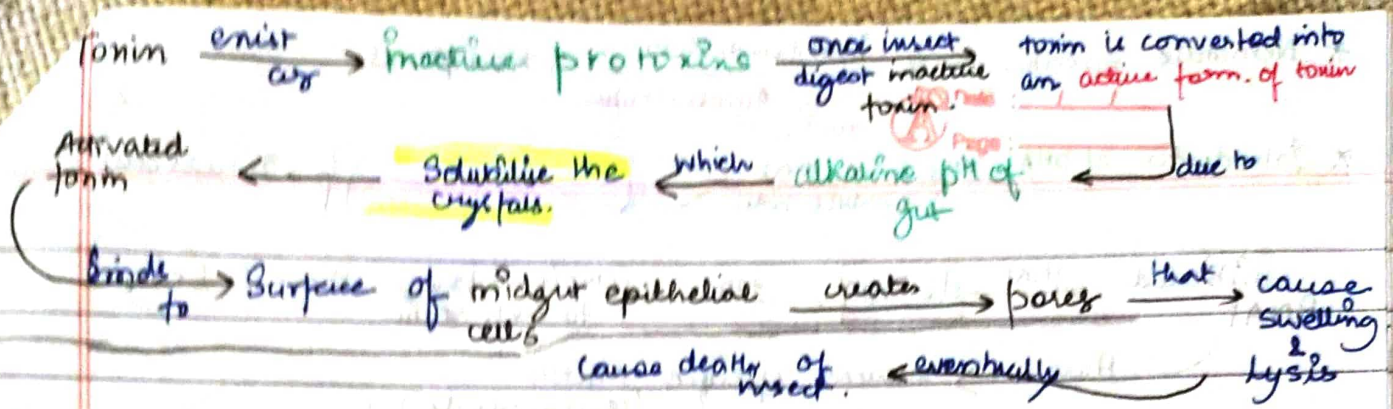
Diptera

- Flies
- Mosquito

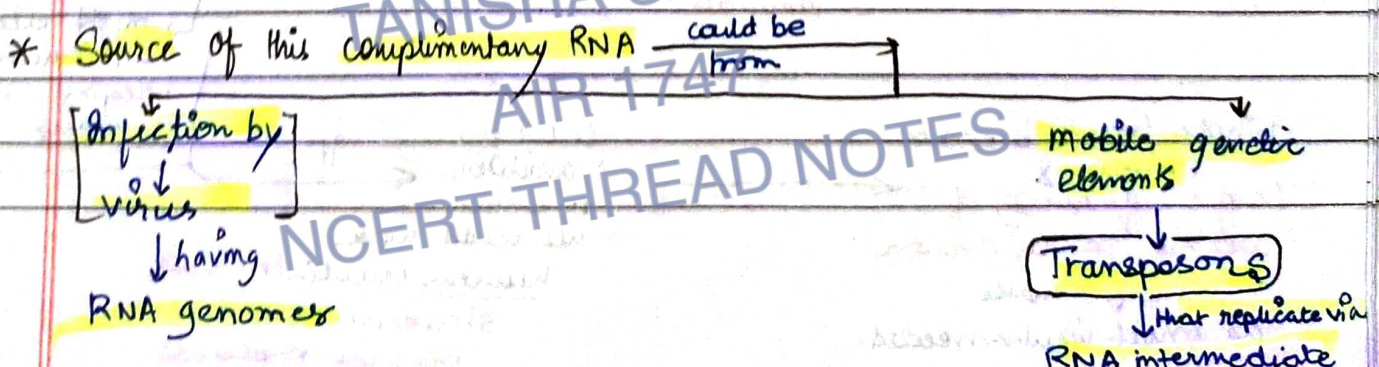
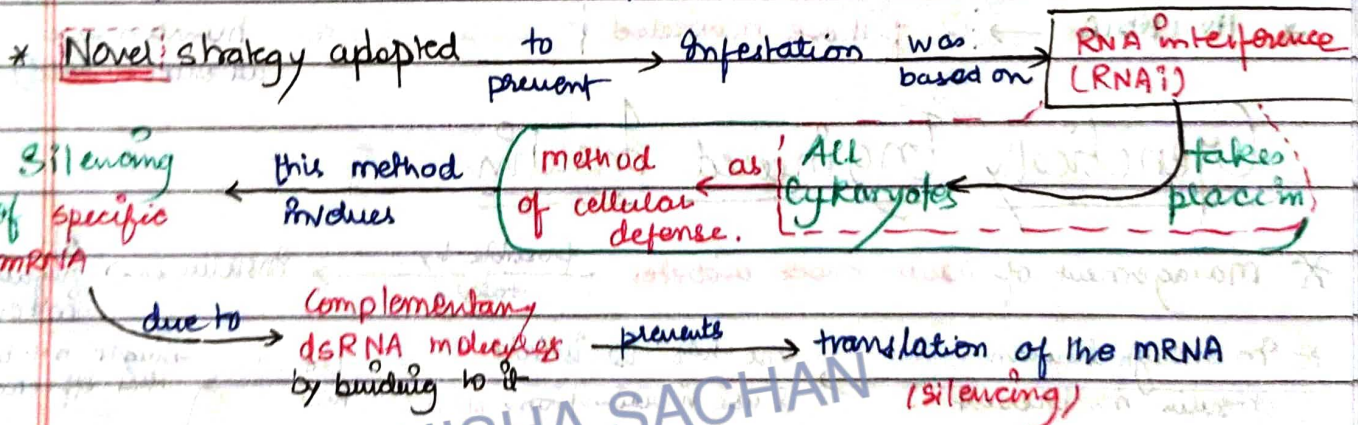
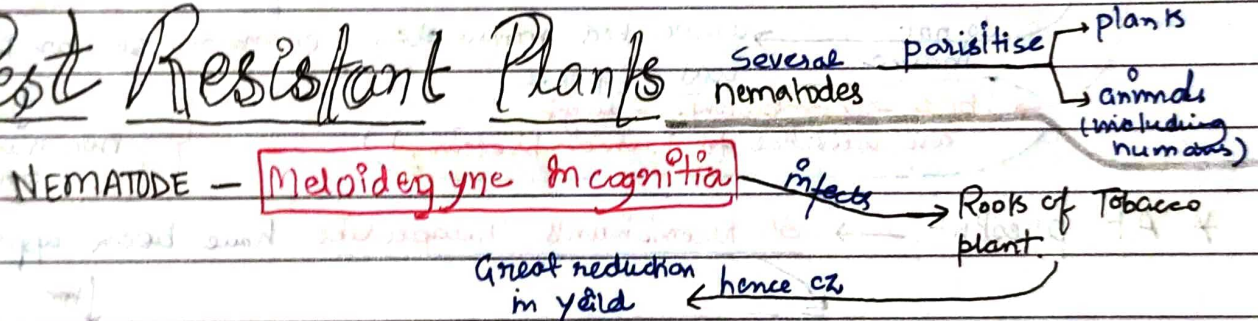
B. Thuringiensis forms Protein Crystals during Particular phase of their growth

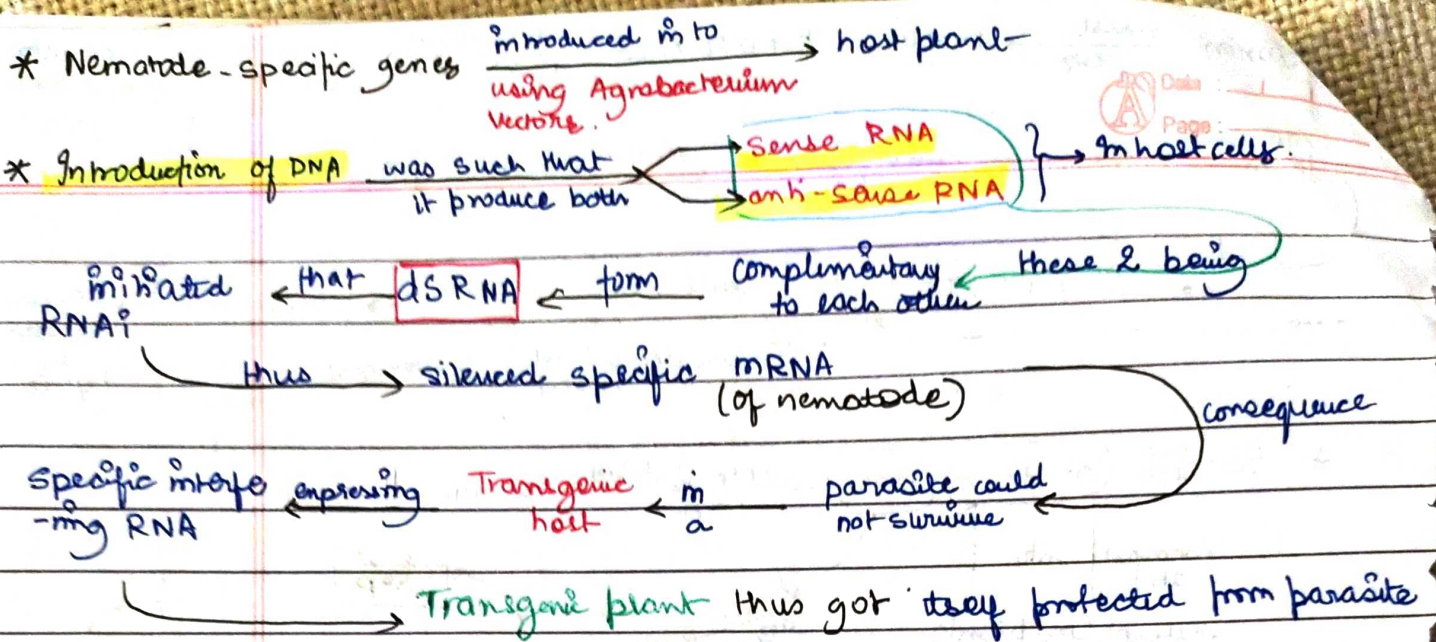
contain

Toxic Insecticidal protein

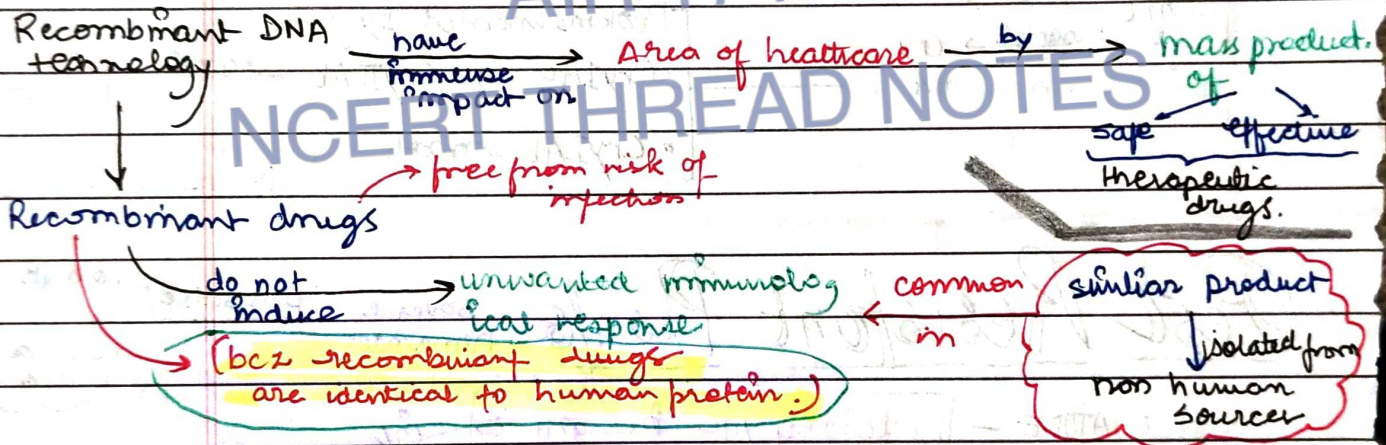


Pest Resistant Plants





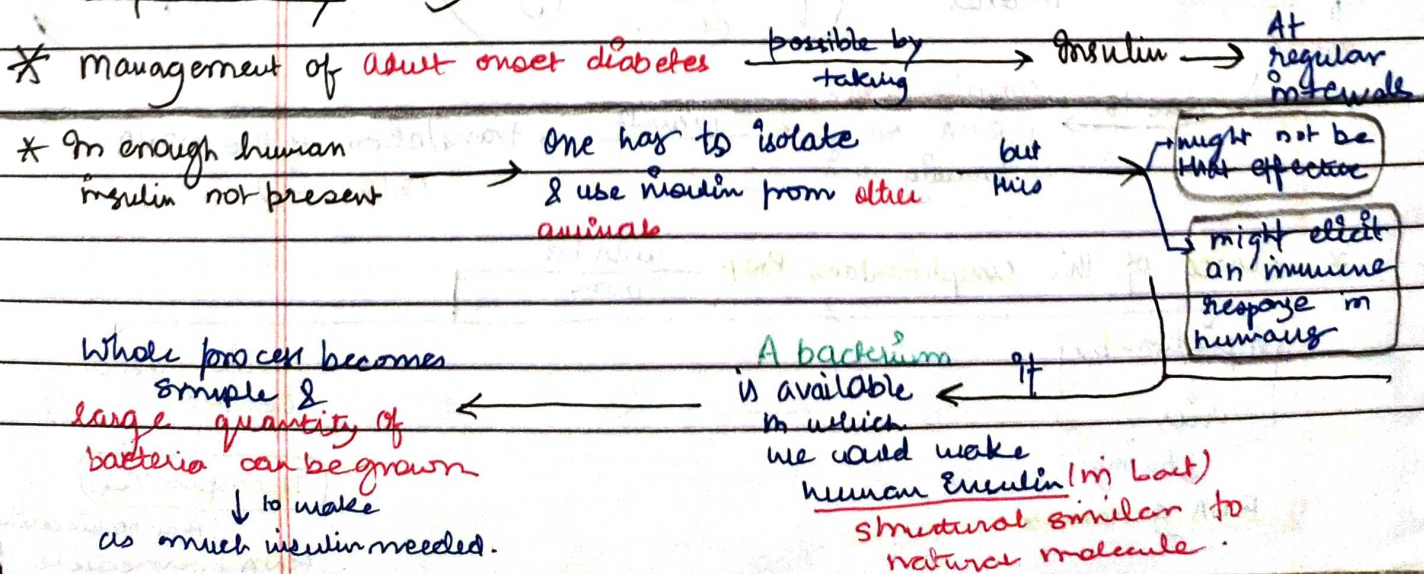
Biotechnological Applications In Medicine

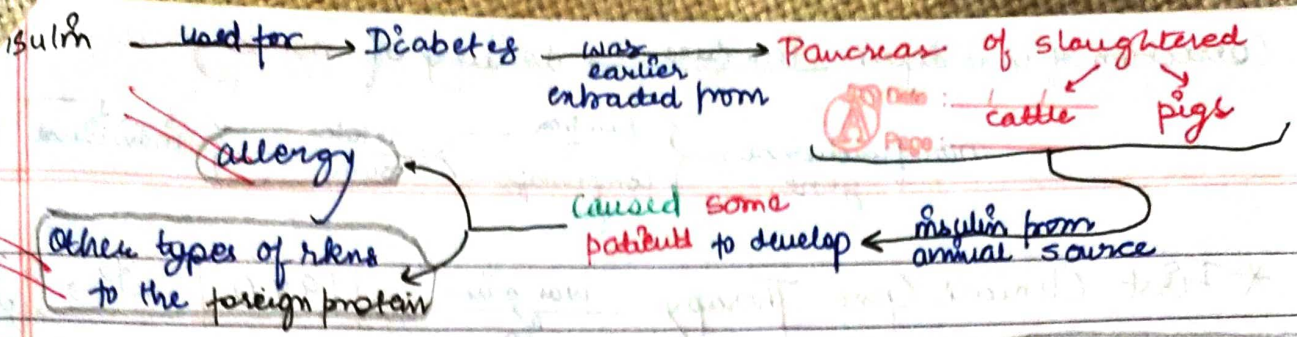


* At present → 30 recombinant Therapeutics have been approved for human use (all over world)

* IN INDIA → 12 of these marketed

Genetically Engineered Insulin



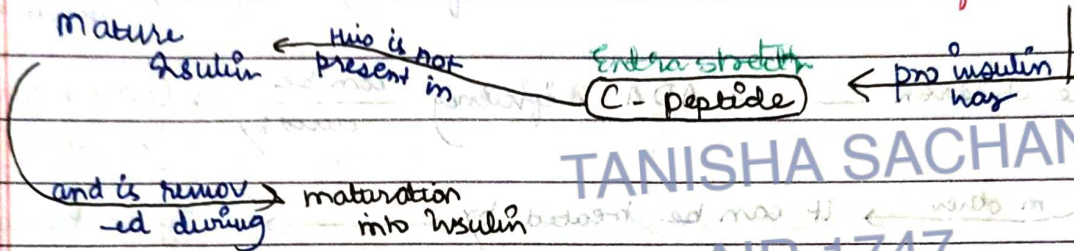


* INSULIN consists \rightarrow 2, short, polypeptide chains

chain A \updownarrow linked by disulphide bridges \updownarrow chain B

In mammals $\xrightarrow{\text{insulin is synthesised as}}$ PRO-HORMONE

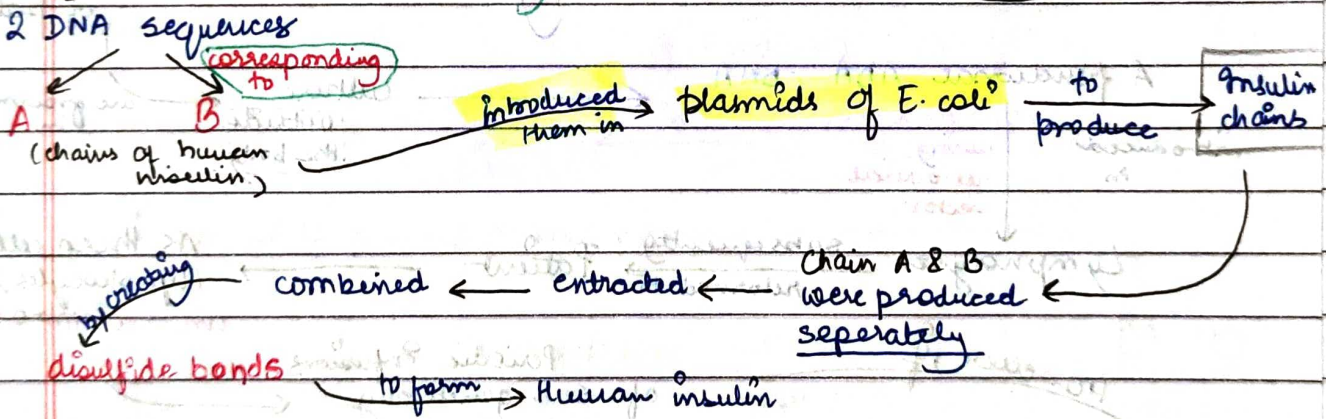
{ like pro-enzyme, pro hormone needs to be processed before it becomes fully mature functional hormone }



* Main challenge for production of insulin $\xrightarrow{\text{using}}$ rDNA technique

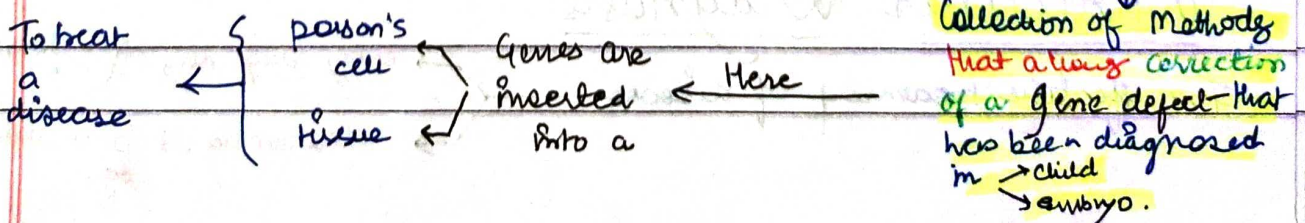
was $\xrightarrow{\text{Getting insulin assembled}}$ into mature form.

in 1983 \leftarrow Eli Lilly (An American company)



Gene Therapy

Person born with hereditary disease \rightarrow Corrective therapy can be taken \rightarrow known as \rightarrow GENE THERAPY



Correction of Gene defect involves delivery of normal gene into individual embryo.
non-functional gene. → function of compensates for → to take over

* First Clinical Gene Therapy was given in 1990 to 4 year old girl

This enzyme crucial for immune system to function → Adenosine deaminase → ADA deficiency → this disorder is caused due to deletion of the gene for adenosine deaminase

* In some children ADA deficiency can be cured by Bone marrow Transplantation
in other it can be treated by Enzyme Replacement therapy
Not completely curable (not curable) → Injection to patients is given by Functional ADA

* As first step towards Gene therapy Lymphocytes from blood of patient

A functional ADA cDNA → culture outside the body → are grown in → Lymphocytes → subsequently returned to Patient → As these cells (lymphocytes) are not immortal.
introduced in → using retroviral vector.
However if Gene isolate from marrow cells prod. ADA → introduced into cells at early embryonic stage → It could be permanent cure.
Periodic infusions of such genetically engineered cells lymphocytes needed.

Molecular Diagnosis

For effective treatment of disease → early diagnosis → understanding its pathophysiology

Conventional Methods of diagnosis eg $\left\{ \begin{array}{l} \text{Serum analysis} \\ \text{urine analysis} \end{array} \right\}$

early detection not possible

- Techniques that serve purpose of early diagnosis $\left\{ \begin{array}{l} \text{Recombinant DNA technology} \\ \text{PCR (Polymerase chain rxn)} \\ \text{ELISA} \end{array} \right.$
(enzyme linked immunosorbent assay)

* Presence of pathogen $\left\{ \begin{array}{l} \text{bacteria} \\ \text{virus} \end{array} \right\}$ is normally suspected when pathogen has produced a disease symptom.

However

* When very low $\downarrow \downarrow$ conc of pathogen present (at time when symptoms of disease not available)

can be detected by

Amplification of their nucleic acid by PCR.

* PCR routinely used to detect HIV in suspected AIDS patient.

used to detect mutations in genes in suspected cancer patients

powerful technique to identify many other genetic disorders.

* Single stranded DNA/RNA $\left\{ \begin{array}{l} \text{tagged with a} \\ \text{Radioactive molecule (PROBE)} \end{array} \right.$ is altered to hybridise to its

Cloned cells in Complementary DNA \rightarrow detection using Autoradiography.

but Photographic film. will not appear on Clone having mutated gene. probe will not have complementarity with mutated gene.

* ELISA is based on Principle of: Antigen - Antibody interaction

Infection of pathogen can be detected by

proteins
glycoproteins

presence of antigen OR

detecting the antibodies \downarrow synthesis of against pathogen

TRANSGENIC ANIMALS

* Animals that have had their DNA manipulated to possess or express an extra foreign gene

TRANSGENIC ANIMALS

Rats Rabbits Pigs Sheep Cows Fish

> 95% of existing transgenic animals are mice

(i) Normal Physiology & Development?

Transgenic animals can be specifically designed to allow the study of how genes are regulated and how they affect normal functions of body & its development

Study of complex factors involved in growth
[e.g. Insulin-like growth factor]

* By introducing genes from other species that alter the formation of this factor.

is obtained about the information biological effects that result and studying Biological role of the factor in the body.

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(ii) Study of disease

NCERT THREAD NOTES

Many transgenic animals are designed to ↑ our understanding of how genes

Species made to serve as models, contribute to development of disease

for human disease so that investigation of new treatments for disease is made

Cancer
Cystic fibrosis
Rheumatoid Arthritis
Alzheimer's

such as

Today transgenic models exist for human disease

(iii) Biological Products

* Medicines required to treat certain human diseases can contain Biological products
Such biolog. prod. expensive to make

Transgenic animals $\xrightarrow{\text{that produce}}$ useful biological products $\xrightarrow{\text{can be created by}}$ reproduction of the portion of DNA / genes
particular products \leftarrow which codes for

Examples:

1) Human protein - α -1-antitrypsin $\xrightarrow{\text{used to treat}}$ Emphysema.
 \rightarrow similar attempts are being made for Treatment of $\left\{ \begin{array}{l} \text{Phenylketonuria (PKU)} \\ \text{Cystic fibrosis} \end{array} \right.$

* In 1997, First transgenic Cow - ROSIE
 $\xrightarrow{\text{produced}}$ human protein enriched milk. (2.4 gm/litre)
Human Alpha-lactalbumin $\xleftarrow{\text{milk contained}}$
 $\xrightarrow{\text{was nutritionally}}$ more balanced product \rightarrow for babies (than cow natural milk)

iv) Vaccine Safety:

* Transgenic mice are being developed for testing the safety of vaccines before they are used on humans.

Transgenic mice $\xrightarrow{\text{are being used to}}$ test the safety of polio vaccine
 \rightarrow If successful \rightarrow Monkeys will be replaced by mice to test the safety of batches of vaccine

v) Chemical Safety Testing:

\rightarrow known as : Toxicity / Safety testing
Procedure is same as \rightarrow that used for testing toxicity of drugs.

Transgenic animals \rightarrow are made to that carry genes which make them more sensitive to toxic subst. than non-transgenic animals.

* Toxicity testing in such animals
 $\xrightarrow{\text{Effects are then studied}}$ Exposed to the toxic substance \leftarrow they are then
 $\xrightarrow{\text{will allow}}$ to obtain results in less time.

ETHICAL ISSUES

* Manipulation of living organism by human race \rightarrow cannot go further, without regulation

* Some ethical standards are req. $\xrightarrow{\text{to evaluate}}$ morality of humans activities that might \rightarrow help harm living organism.

Beyond morality of such issues

Biological significance of such things important.

Genetic modification of organism

When such org. are introduced in ecosystem.

unpredictable results

can have

therefore

Indian Government.

has set up

GEAC (Genetic Engineering Approval Committee)

①

Validity of GM research

Decisions regarding

which will make

②

Safety of introducing GM-org for public services

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NCERT THREAD NOTES

* The modification of usage

of living organisms

for Public Services

food source

medicine source

problems with patent granted for same

has created

* Growing public anger.

that

Certain companies

are being granted

Patents

for

products technologies

farmers
indigenous people
of specific region/country

by

long been identified developed used

that have

other biologic resource
Genetic material
plants

that make use of

RICE - Imp food grain

- Presence goes back 1000+ years in Asia's agricultural history.

- Estimated - 200,000 varieties of rice in India alone.

- Diversity of rice - In India - one of the richest in world.

- BASMATI RICE - distinct for unique aroma flavour

↳ 97 documented variety of Basmati

grown in India

- Reference to Basmati in

ancient texts
folklore
poetry

as it has been grown for centuries.

- In 1997, An american company

got

Basmati rice

through

US patent & Trademark office

His allowed company to

Sell 'new' variety of Basmati in

US

abroad.

His new variety is derived from.

Indian farmer's variety

Indian Basmati

X Semi dwarf varieties

claimed as

Invention/novelty

patent extends to → functional equivalents → implying that other people ~~could~~ ^{could be restricted by patent} selling Basmati Rice

* Several attempts ^{has been made to} Patent → uses products processes } based on Indian Traditional Herbal Medicines [e.g. Turmeric Neem]

* Hence { If we are not vigilant } → other countries may encash on → Rich legacy
Do not immediately counter these patent application

⇒ BIOPIRACY — Use of bioresources by multinational companies other organisations
Compensatory payment ← without countries people concerned from Authorisation ← without proper

* Most of Industrialised Nations { rich financially }
poor in biodiversity & traditional knowledge

* Developing & Underdeveloped world → rich in { Biodiversity } related to Bio Resources
Traditional Knowledge

Modern application ← can be exploited to develop Bio resources
can also be used to save { effort time expenditure } during ~~Research~~ Commercialisation

* Growing { unjust inadequate compensation } → sharing b/w developed & developing countries
Benefits

Such unauthorised exploitation of their bioresources → Therefore some nations are developing laws to prevent

* Indian Parliament

recently cleared

Second Amendment of Indian Patents Bill

Date: _____
Page: _____

patent terms emergency provision

Research

Development inhibitive

including

such issues into consideration

that sake

GOLDEN RICE

Vit A

β -carotene

precursor for provitamin A

Blood

doesn't have

~~protease~~

~~nuclease~~

Orally active pharmaceutical protein

used for treatment of

hepatitis B

influenza

Herpes

only problem is they can get digested/denatured by stomach acidic environment, hence they are encased in tablets which solubilise in intestine & they are directly absorbed.